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EFFICIENT OPERATION AND ECONOMICAL EXPANSION OF UNDERGRADUATE TEACHING FACILITIES OF URBAN UNIVERSITIES. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS BASED ON A CASE STUDY OF DREXEL INSTITUTE OF TECHNOLOGY, PHILADELPHIA, PENNSYLVANIA.

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INFORMATION CONCERNING EFFICIENT PLANT OPERATION AND ECONOMIC FACILITY EXPANSION TO BEST ACCOMMODATE INCREASED STUDENT ENROLLMENTS AT URBAN COLLEGES AND UNIVERSITIES WAS GENERATED FROM A CASE STUDY OF THE DREXEL INSTITUTE OF TECHNOLOGY. GENERAL AREAS INVESTIGATED WERE--(1) SPACE REQUIREMENTS WHICH WILL MEET ANTICIPATED INCREASES IN ENROLLMENT, (2) SPACE ARRANGEMENT FOR INTENSIVE AND EFFICIENT UTILIZATION OF THE PHYSICAL PLANT, (3) USE OF MULTI-STORY BUILDINGS TO COMPENSATE FOR HIGH LAND COSTS, (4) ECONOMICS OF BUILDING UNITS WHICH CAN LATER BE EXPANDED VERTICALLY, (5) POSSIBLE CONVERSION OF ADJACENT BUILDINGS, (6) PHASING OF FINANCING AND CONSTRUCTION WITH REGARD TO INFLATION, AND (7) PROVISION FOR SATISFACTORY PARKING. A METHODOLOGY FOR DETERMINING FUTURE SPACE REQUIREMENTS WAS DEVELOPED AND USED IN CONJUNCTION WITH SEVERAL PLANNING AND FEASIBILITY STUDIES TO DEVELOP SPECIFIC RECOMMENDATIONS FOR DREXEL INSTITUTE. INCLUDED ARE TABLES ON ALTERNATIVES FOR NEW BUILDING DEVELOPMENT, AND AN EXHIBIT OF THE FORMS AND INSTRUCTIONS FOR THE FACILITIES REQUIREMENTS METHODOLOGY. (BH)

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Efficient Operation and Economical Expansion of Undergraduate Teaching Facilities of Urban Universities

Findings, Conclusions, and Recommendations based on a Case Study of Drexel Institute of Technology Philadelphia, Pennsylvania

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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PART I

Purpose and Scope of Study

One of the functions of the Educational Facilities Laboratories, Incorporated, is to develop a fund of information which may be drawn upon by educational institutions attempting to improve operating efficiency or to develop new facilities which will yield a maximum return for a minimum investment.

American higher education is confronted with an unprecedented challenge. Facilities must be developed capable of handling, by 1970, perhaps *100%* more students than are now accommodated in our colleges and universities. Schools will have to operate more intensively and efficiently and more students will have to be accommodated in existing classrooms and laboratories. Billions of dollars of new construction will also be necessary.

A larger percentage of greater numbers of high school graduates will make application for college in future years. More students will come from middle and lower income families. Of necessity, or by preference, more will live at home and commute for full-time or part-time study.

With the population of the United States increasingly concentrated in metropolitan complexes, urban colleges and universities will have to carry an even heavier responsibility than now.

Aware of these trends, officers of the Educational Facilities Laboratories, Inc., felt that a study of higher education in a typical urban center would be rewarding. After a review of the situation in Greater Philadelphia, it was decided that a detailed case study of the problems and challenges of operating and expanding faced by one institution, Drexel Institute of Technology, would permit the development of information useful to a wide variety of urban institutions of higher education throughout the country.

CHARACTERISTICS OF DREXEL INSTITUTE OF TECHNOLOGY[1]

Drexel is an urban university, centrally located, readily accessible by public and private transportation, and open and in use from early morning until late night throughout the year. As is the situation in many other such institutions, intensive, efficient use of the available physical plant has made it possible to provide educational services at a cost comparatively moderate for scientific and technological curricula, and under circumstances which permit large numbers of persons to benefit.

Geographical location has been one of the major factors influencing steadily increasing demands upon Drexel: by young high school graduates, who of necessity or by choice, live at home and commute to school (four-fifths of Drexel's day students and almost 100% of evening and graduate students are commuters); by young people who wish to combine their college education with practical experience under Drexel's program of cooperative education or who must, of necessity, earn while they learn; by adults, who are ambitious to advance themselves in their industrial employment by studying nights for their baccalaureate or master's degrees in scientific and technological fields; and by the several thousand companies of the Greater Philadelphia area which are increasingly dependent on the Institute's graduates, which collaborate in research activities, and which are direct and indirect beneficiaries of the Institute's educational services.

Over 500 companies participate regularly in the Drexel program of cooperative education or are represented by their employees in the evening graduate and undergraduate enrollments. The productivity of Drexel's cooperative students in their places of employment may be taken from the more than $4,000,000 earned by 2500 students in their assignments in the year 1959-1960.[2]

With the exception of a few courses, the Institute is now operating virtually at capacity. Further enrollment increases, extensions of existing programs, and introduction of new and critical curricula and educational services can be accomplished only by additions to staff and physical plant—this despite the fact that population

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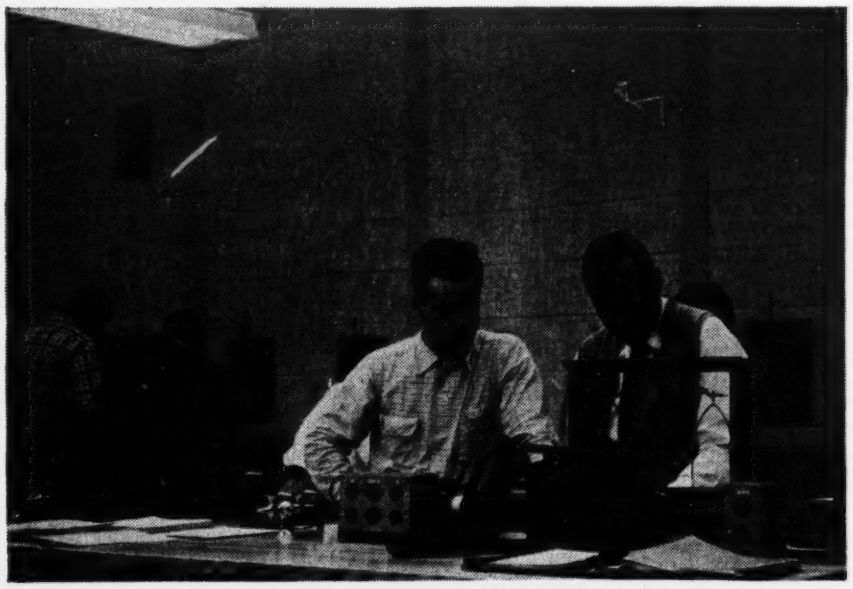
[1] The general characteristics of the Institute and a statement of its operating and expansion achievements and problems are succinctly defined in a document entitled "An Interpretive Memorandum for the Senate and House Appropriation Committees of the General Assembly of the Commonwealth of Pennsylvania" May 1, 1959. This document was reprinted as Volume 11, No. 1, Spring, 1959 of the Drexel Institute of Technology *Alumni News* and is available upon request to the Institute's Alumni Office.

[2] A detailed study of cooperative education in American colleges and universities has been recently completed by the Thomas Alva Edison Foundation which has offices at 8 West 40th Street, New York 18, N. Y., and is available to interested institutions through that organization.

studies indicate that Drexel has not yet begun to serve the larger high school graduating classes of students who were born during the baby-boom years.

Expansion Problems

Drexel's expansion problems are typically those of many urban universities. While a central location has been, and will increasingly be, a major factor in the steadily increasing demand for Drexel's educational services, it has also posed major problems inhibiting expansion. Land adjacent the present facilities is intensively used and expensive. Drexel's endowment, small in comparison with other institutions serving the same number of students (some 8000 per year), is so restricted that no substantial sums can be released for purchases of land or development of plant. Of necessity, additional capital for development purposes has been sought, and with some measure of success, through appeals to industry, foundations, alumni, and the general public. During the past 18 months, for the first time in the 69 year history of the Institute, assistance from the Commonwealth of Pennsylvania has also been sought and obtained in modest amounts, both for operating and capital purposes. However, it has become increasingly clear that the rate at which capital funds can be accumulated for physical expansion makes it imperative that the trustees use available capital with the utmost care and foresight if projected demands for educational services are to be met.



Drexel's facilities are never idle. After the full-time day students leave, their places are taken in classrooms and laboratories by evening part-time graduate and undergraduate students.

Expansion Plans Based on Studies by Consultants

All expansion plans undertaken to date have been predicated on objective studies by outside consultants. In 1955 the Drexel trustees authorized the firm of Alderson & Sessions, Management Consultants, to undertake a comprehensive survey of the "markets" for the Institute's services, namely, the primary or student market and the market for graduates—the secondary market. The study completed in 1956 revealed that if Drexel merely maintains its present relationship to the educational markets of the Delaware Valley, it will have to serve a minimum of 85% more students by 1970. It also revealed that if Drexel supplies its present share of the professional personnel to be required, the demand for Drexel graduates will be 87% higher by 1970.

In 1957, the trustees authorized an area study by a firm of city planners, Cooper, Alvare, and Harkins, to define the land areas most readily available and best suited to Drexel's use and to develop a preliminary plan for presentation to the appropriate city and federal agencies.

Efficient management of a compact physical plant in which available classrooms and laboratories are used intensively with a minimum of down-time can yield significant operating economies. This was found to be the case at Drexel. Nearly 90% of operational costs have been met in the past by income from tuition and fees. In the years immediately past, Drexel has made successive increases in tuition and fees. Further increases will be necessary if current price trends continue and the Institute is not able to reduce operating costs or increase income from other sources.

New Challenges for Urban Universities

Urban institutions like Drexel will be called upon to expand and assume their share of increasing numbers of students and of collateral educational services and research. Basic questions are whether they can improve the operating efficiency of their present facilities or, if they have already achieved an extremely high degree of operating efficiency, whether they can achieve an even higher level of efficiency in an expanded plant. For Drexel, or any comparable institution, higher efficiency could mean a reduction in overhead costs which would release funds to maintain a faculty of high standing or to forestall further substantial tuition increases which might deprive certain young people of educational opportunities.

Questions to be Answered Through Case Study

It was decided, after a review of the circumstances and problems affecting Drexel and after due consideration of the service that might be rendered comparable institutions, that, using Drexel Institute of Technology as a case study, an Educational Facilities Laboratories grant should underwrite a detailed professional analysis of the following questions:

1. How can an institution calculate specific space requirements which will meet anticipated increased demand for undergraduate educational services?

2. How can additional space be arranged so as to facilitate the continuance or improvement of an intensive and efficient utilization of physical plant?

3. In face of high land costs, can multiple-story buildings be recommended for educational purposes?

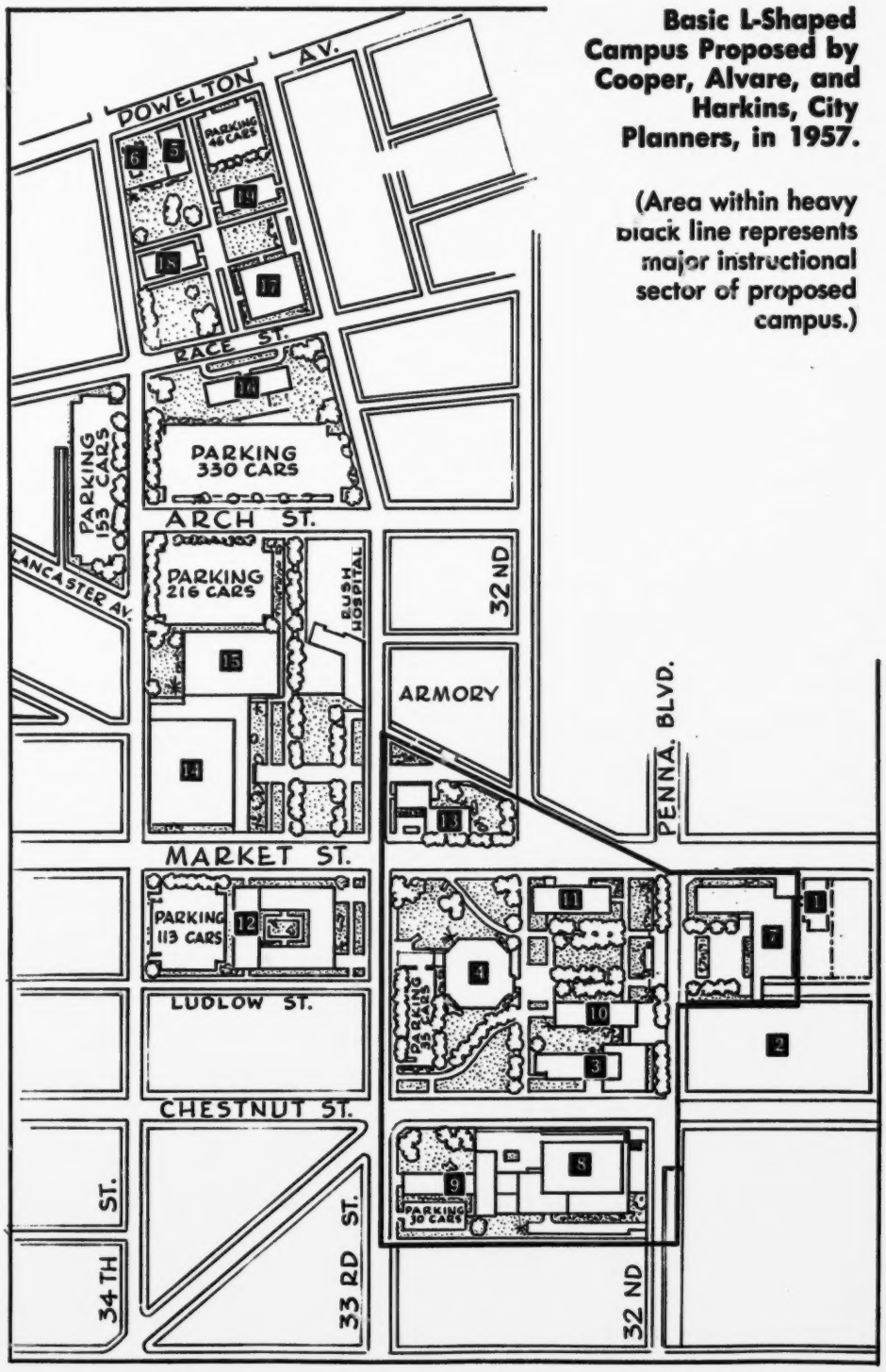
4. If capital funds for physical expansion can be accumulated only gradually, what are the economics of constructing low building units which can later be expanded vertically?

5. If adjacent land is already occupied by commercial and industrial buildings, and if there is an urgent need to provide additional educational space at the earliest possible date, what are the considerations that enter into purchasing and converting such buildings?

6. To what extent should progressive inflation of building costs, and general prices be taken into account in phasing the financing and construction of a physical plant adequate to met future needs?

7. What is the most satisfactory and economical way of resolving the parking problem of urban educational institutions?

The methods and findings of the case study of Drexel Institute of Technology in respect of the above questions are indicated in Part II. Part III suggests the practical application of these findings and conclusions to certain of Drexel's expansion projects.



Basic L-Shaped Campus Proposed by Cooper, Alvare, and Harkins, City Planners, in 1957.

(Area within heavy black line represents major instructional sector of proposed campus.)

The basic L-shaped campus plan prepared in 1957 for Drexel Institute of Technology by Cooper, Alvare and Harkins, City Planners, is shown above. Legend: Then existing structures were: (1) Old Student Union Building (abandoned after explosion in 1955, but site considered as possible location for Nuclear Engineering Laboratory); (2) Main Buildings — Main, Randell Hall, Curtis Hall and Alumni Engineering Laboratories Building; (3) Basic Science Center; (4) Library Center; (5) Van Rensselaer Dormitory for Women; (6) Home Management House. Proposed structures are: (7) Classroom and Laboratory Building; (8) Student Activities Center; (9) Classroom Building; (10) Basic Science Center Addition; (11) Classroom Building; (12) Classroom Building; (13) Cultural Center; (14) and (15) Physical Education Center; (16) Women's Dormitory; (17) Dining Hall; (18) and (19) Men's Dormitories.

PART II

Methods, Findings, and Conclusions

Determination of Future Space Requirements[3]

Question 1: How can an institution calculate specific space requirements which will meet anticipated increased demand for undergraduate educational services?

Objective studies of Drexel's primary (student) and secondary (employer) "markets" conducted by the firm of Alderson and Sessions, Management Consultants, had indicated that if Drexel were to prepare to accommodate only its usual share of the larger numbers of students who would seek admission, it would have to plan for an 85% increase in enrollment by 1970. In order for Drexel to continue to benefit from an intensive and economical utilization of space, it was important that future construction be predicated on a precise definition of the requirements for each kind of space—classrooms, lecture rooms, drafting rooms, laboratories, and faculty offices.

A. Method Used to Determine Additional Classrooms Needed

1. Each department head was asked to determine what number of students would constitute the most economical unit of growth in his particular department. The size of the units varied from department to department and from course to course within departments.

2. The Admissions Office was consulted in order to determine the probable breakdown by major fields of the 85% increase in enrollments projected by the Alderson & Sessions study.

3. A Master Form was developed *(Exhibit B)* and instructions for its use *(Exhibit C)* on which was listed, by departments, every course taught in Drexel's day colleges. For each course, the following information was shown: number of students in the course, Fall Term, 1959; number of sections or groups of students in the course; optimum or most desirable number of students per section; maximum number of students who could be taught in a section; type of room required (classroom, lecture room, etc.); number of periods per week; length of the period; and time needed to prepare or dismantle demonstration rooms.

4. The next column of the Master Form showed, by school or department, the number of additional students who might be expected by 1970. Figures in this column, added to enrollments in the Fall of 1959 gave, by course, the expected total for 1970. A division of this figure by the optimum number of students per section revealed the number of sections to be accommodated in 1970.

5. The projected number of sections for 1970 was multiplied by the number of hours per section per week in order to determine the total room-hours per week.

For classrooms it was assumed that Drexel's current high utilization factor (75%) could be maintained. Therefore, it was possible to divide the total room hours by 31 to determine the number of classrooms required (namely 38). (See *Exhibit D*)

The divisor 31 represented the total number of day-time hours between 9:00 and 5:00, Monday through Friday, during which classes for instruction could be held.[4]

B. Method Used to Determine Additional Laboratories and Lecture Rooms Needed

Because of the specialized nature of laboratories and lecture rooms, it was not possible to use the simple arithmetic indicated under A 1-5 above. Therefore, the laboratory and lecture classes projected for the year 1970 were actually "scheduled" by hours and days in order to project the total additional need for 9 laboratories; 2 large lecture rooms, each seating 200; and 2 small lecture rooms, each seating 100. Other small lecture rooms were considered as classrooms. A sample of the Schedule Form used for these calculations is annexed as *Exhibit E*.

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[3] See *Exhibit A* for instructions issued to Deans of Drexel's several colleges.

[4] In this connection, see also page 7 of this Report. The facilities available for day-time use are also used, to capacity, by evening graduate and undergraduate students. Separate calculations to cover evening requirements were, therefore, considered unnecessary.

C. Method Used to Determine Additional Faculty Offices Needed

Calculations under heading A 4 above had indicated the number of sections. These figures were given to the department heads and they were asked to indicate the present size of their teaching staffs and the projected size for 1970. (See *Exhibit F*). From these figures, it was estimated that 118 more faculty offices would be required by 1970. *(Exhibit G)*

Summary of Specific Space Requirements

In summary, the above calculations revealed a need for an additional 38 classrooms, 9 laboratories, 2 drawing rooms, 118 faculty offices, and 1 large lecture room. To this had to be added 14,600 sq. ft. for accessory educational space such as dark rooms and storage, 8100 sq. ft. of maintenance space, and 27,100 sq. ft. for corridors, stairways, toilet rooms and service areas. In all this represented a need for 108,500 sq. ft. of gross building area in order to meet the requirements projected for 1970 for an expanded program *of day-time undergraduate instruction*. This is an increase over existing space of 36%. *(Exhibit H)*

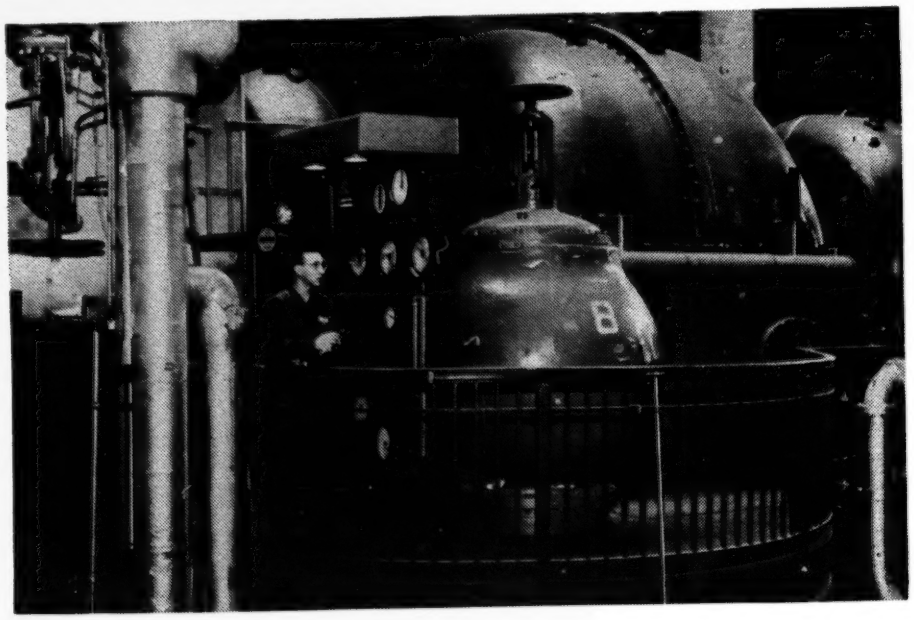
To this must be added the replacement of space now occupied on a temporary basis of 39,770 sq. ft. in the Lancaster Avenue Annex, the Woodland Avenue Annex, the Mathematics Building, the "A" Annex and the "B" Annex. These structures will be demolished or vacated in order to make room for the proposed expansion. *(Exhibit H)*

The estimated total additional square footage required checked closely with a projection made for Drexel by the firm of Cooper, Alvare, and Harkins, City Planners, in connection with the preparation of a document for presentation to the City Planning Commission in 1957. However, that report attempted no definition of the manner in which the estimated total square footage was to be broken down into classrooms, laboratories, offices, and other uses.

The method used here to compute those space requirements leaves the Institute with a collection of data which has value for a periodic review and reappraisal of this problem as well as for consideration of the cost of instruction itself.

An Anomaly Resolved

A question was logically raised as to why, if Drexel were living up to its reputation of using its space so efficiently, only 36% more educational space would be needed to take care of an 85% increase in *full-time undergraduate* student enrollments.



Educational capacity is greatly enhanced by the Drexel Plan—Co-operative Education—under which full-time day students alternate terms of on-campus study with terms of paid internships in over 500 companies and professional offices located in 16 states.

Several considerations account for this apparent anomaly. First, Drexel's intensive and efficient use of space had applied primarily to classrooms which are flexible and interchangeable between courses. Specialized laboratories are far more restricted and cannot readily be used by other departments. This is illustrated by the fact that the existing laboratories, most of which are highly specialized, will take care of many of the additional student sections. Only 9 laboratories in addition to the present 81, 11% more, are required. In contrast, the addition of 38 classrooms is a 52% increase.

Second, the College of Home Economics, which now has 7.5% of the day-time student population, can accommodate an enrollment increase with practically no additional space except offices for a larger staff.[5]

Third, and most significant, is the fact that, all of Drexel's engineering and science students, most of the business administration students, and many of the home economics students study under the program of cooperative education. This means that, after the freshman year,

[5] However, to the extent that the College of Home Economics depends on departments outside the College to meet instructional requirements (English, mathematics, etc.) increases in Home Economic enrollments do tend to increase space requirements.

most of the day-time undergraduate students spend only six months (two quarter terms) on campus each year. Since groups of students alternate in industrial and professional assignments, each classroom added can do practically double duty.

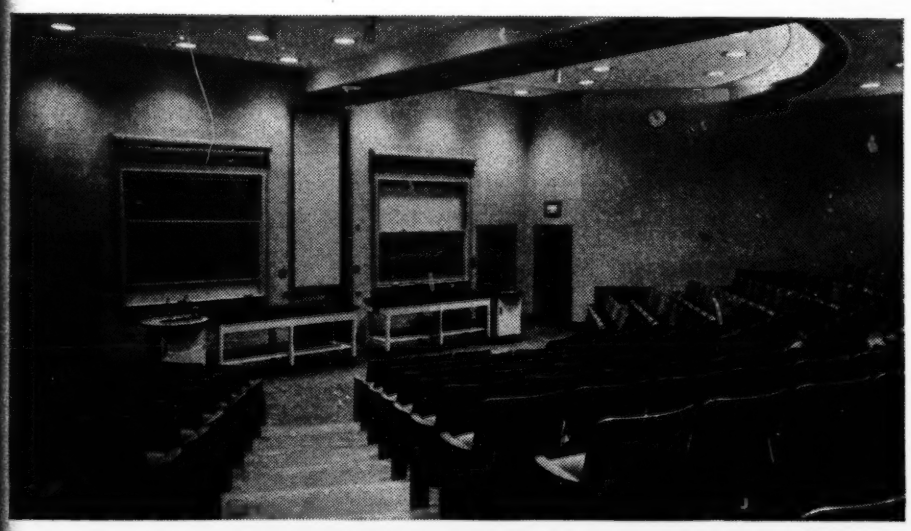
ARRANGEMENT OF SPACE TO MAINTAIN HIGH UTILIZATION

Question 2: How can additional space be arranged so as to facilitate the continuance or improvement of an intensive and efficient utilization of physical plant?

Analysis of room use made it apparent that the present high utilization of teaching area was due to its common use by all departments and the lack of departmental proprietary ownership—coupled with central scheduling. If these practices are to continue it is necessary that new buildings for teaching be located as close as possible to the present Main Building, the Basic Science Center, and the Library. The spreading of teaching buildings over several city blocks suggested in one proposed plan of expansion would seriously impair present efficiency.

The typical college campus with scattered buildings of specialized use is inefficient in the use of space. Academic departments develop a proprietary feeling about the classrooms or other facilities in their building and these rooms may stand empty better than half the time. In some instances an individual professor may stake claim in a particular room because it is near his office. He may not only insist that he teach in no other room but may also insist that no one else teach in his room.

Over the years, there is a wide fluctuation in the popularity of various disciplines or studies as well as in the techniques of teaching. Hence, the building of classroom facilities usable by only one department may create unused rooms in one building and a great shortage of rooms in another. It is conceded that these separated buildings do make a campus more attractive and that they may also make it easier to cultivate a potential donor when he can have the separate building carry his name. On the other hand, interconnected or integrated buildings such as those at Massachusetts Institute of Technology make it easier to have a central agency effectively schedule the use of rooms rather than have individual departments schedule their own.



Intensive utilization of space at Drexel is accomplished both by central scheduling of all facilities and by construction of multiple-purpose rooms. Illustratively, the 200-seat Campbell Auditorium in the Basic Science Center may be divided into two separate 100-seat demonstration-lecture halls by an electrically operated mobile partition (arrow). Exhibits can be prepared and stored in an adjacent room, moved into position on wheeled tables and connected quickly to fixed utility outlets.

National Studies of Classroom Utilization

There is increasing interest in room utilization on the part of many colleges. Some of them have undertaken their own studies and others have had this done by outside agencies. A committee of the American Association of Collegiate Registrars and Admissions Officers published a book on this subject in 1957.[6] In this book they have indicated a method of measuring room utilization as well as the use of the seats within a room. They have also published tables showing results of these measures in a number of reporting institutions. These are some of the shocking figures drawn from these tables:

1. Of 90 institutions reporting, 60% indicated that their classrooms were used less than half of the total school hours per week.
2. Of 88 institutions reporting, 80% indicated that their teaching laboratories were in use less then half of the total school hours per week; 40% reported that these labs were in use less than one-third of the time. During these relatively few hours of usage, in 90% of the cases less than 75% of the seats in the rooms were occupied.

Drexel Use Factor Extremely High

In contrast with these figures, Drexel was found to have an extremely efficient operation so far as classroom usage is concerned. Using the accepted method of meas-

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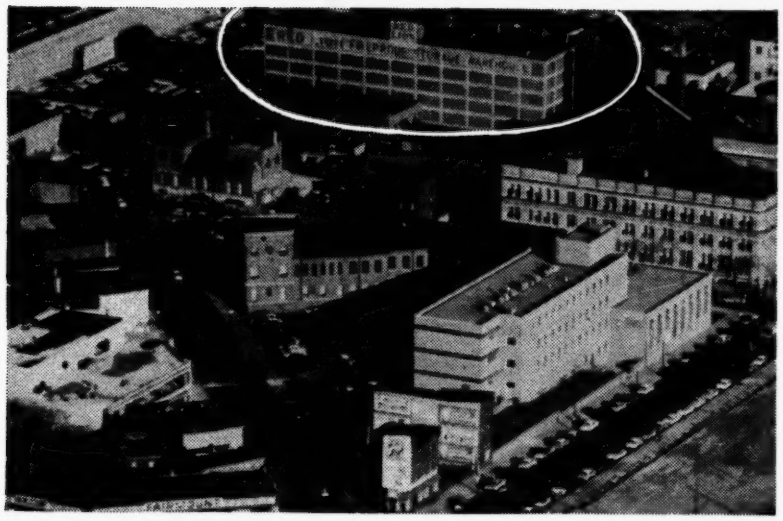
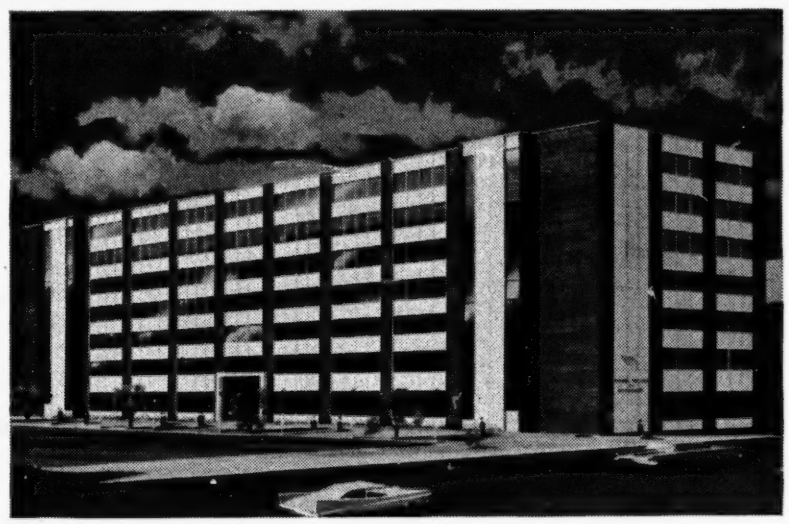
[6] *Manual for Studies of Space Utilization in Colleges and Universities,* by John Dale Russell and James I. Doi. Published by American Association of Collegiate Registrars and Admissions Officers, Ohio University, Athens, Ohio.





Studies showed that the Red Lion Storage Warehouse adjacent to Drexel's principal academic buildings could be adapted for educational purposes at a substantial saving of time and money. An artist's view of the completed renovation is shown at right. Architects are Supowitz and Demchick.

uring, its classrooms were found to be in use about 75% of the time. Even this does not adequately represent the intensity of usage at Drexel. Because it is so largely a commuting college, it is difficult to schedule classes at 8:00 A.M. or on Saturday mornings because of the inadequacy of public transportation facilities at those times. Furthermore, the required drill given to most of the R.O.T.C. students on Thursday afternoon eliminates the possible use of two periods, and the common extracurricular activity period on Tuesday afternoon eliminates the possible use of two more periods. With these allowances, it may reasonably be concluded that Drexel is using its classrooms about 81% of the possible daylight hours. On top of this can be added the extra evening use of these rooms by the day college Graduate Divisions and the Evening College (which is difficult to measure with a percentage) and the fact that the Institute operates 12 months of the year.[7]

Effect of Compact Operation on Costs

From these facts it is a finding of this study that a significant factor in the ability of Drexel Institute of Technology to provide a good education at relatively low cost lies in the compactness of the teaching facilities which have produced a high utilization of space. The additional teaching space needed to meet an increase of 85% in enrollment by 1970 would have to be planned in such a way as to maintain this compactness if present economies of operation are to be continued.

Ability to develop or maintain a compact operation may be frustrated in urban settings, by two factors sometimes beyond the control of the educational institution:

1. local zoning laws or other regulations which do not permit the development of a completely rational plant; and

2. the flow of traffic on streets separating the various buildings of the campus. Observations regarding the situation in this regard at Drexel are given on page 16 in Section III of this report.

USE OF MULTIPLE-STORY BUILDINGS FOR EDUCATIONAL PURPOSES

Question 3: In face of high land costs, can multiple-story buildings be recommended for educational purposes?

Visits to other universities using multiple-story buildings were made and discussions were held with the elevator companies. It was concluded that there are no practical operating difficulties with educational buildings up to 12 floors high. Various expedients can be used to expedite traffic, such as keeping the classrooms on the lower 3 or 4 floors, having elevators stop at every other floor, etc. The answer to the question of advisability of multiple-story buildings up to 12 floors is, therefore, largely economic.

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[7] The total usable daylight hours at Drexel are 9, 10, 11, 12, 1:30, 2:30, 3:30 and 4:30 on Mon., Wed. and Fri. — 9, 10, 11, 12, 1:30 and 2:30 on Tues. and Thurs. or a total of 36. Scheduled use of 31 out of 36 hours equals 81%.

Illustratively, an average educational building of 40,000 square feet, with basement and 3 floors and with a ground area of 10,000 square feet, would require one elevator. Two such buildings would require two elevators. If the same area were provided by a 7-story-and-basement building, three elevators would probably be needed. The cost of the additional elevator would be $45,000 or $4.50 per square foot of ground area. To offset this partially, the cost of entrances, lobbies, walkways and landscaping would be about half for the high building of what it would be for two low buildings.

Under the circumstances, it would seem that any time the cost of land approaches $4.50 per square foot an analysis should be made of any particular project and its size, use, and the land availability to determine whether it should be higher than the customary 3-story-and-basement.

Massachusetts Institute of Technology is now contemplating a laboratory building up to 20 stories in height. Harvard and Cornell are both planning dormitories above the former 4-story level. Columbia and New York University are both successfully using high-rise buildings.

ECONOMICS OF BUILDING LOW UNITS WHICH CAN LATER BE EXPANDED VERTICALLY

Question 4: If capital funds for physical expansion can be accumulated only gradually, what are the economics of constructing low building units which can later be expanded vertically?

To help answer this question, a typical educational building was selected which was fifty feet wide with columns not placed in the center of the fifty feet, allowing for offices on one side of the building with a corridor and classrooms or laboratories on the opposite side. The live load was assumed as 60 lbs./square feet.

The structural engineering firm of Seelye, Stevenson, Value and Knecht of New York City was employed to actually design the foundations, the column, the floor slabs and roof slabs for a typical 20 by 50 foot bay of such a building. Foundations were designed for average soil conditions and also for poor soil conditions which would necessitate using piles. The building was first designed as a 3-story-and-basement building with no provision for vertical expansion. It was then designed with provision to expand it to 8 floors and also 12 floors.

It is obvious that the only significant variation in the design of these buildings would be in the size of the columns and footings. The floor and roof slabs would be the same whether or not the building was designed for vertical expansion.

The structural designs were turned over to Professional Estimators, Inc. of Princeton, N. J., who established actual costs for the columns and footings under the various schemes considered. These costs were divided by the number of square feet supported by these columns. The results are shown in Table I below.

Conclusion

The additional cost per square foot of gross building area to make a 3-story-and-basement building expandable to 8 stories is $.84 per square foot of gross building area. If a typical college building can be assumed to cost $20 per square foot, this increase would represent about 4% of the original cost and would appear to be sufficiently

TABLE I

THE COST OF COLUMNS AND COLUMN FOOTINGS FOR A THREE-STORY AND BASEMENT REINFORCED CONCRETE BUILDING

(Costs are per square feet of Gross Building Area)

	Average Foundation	Pile Foundation
No provision for Expansion	$ .57	$1.05
Expandable to 8 stories	$1.41	$2.26
Premium for expansion to 8 stories	$ .84	$1.21
Expandable to 12 stories	$1.92	$3.00
Premium for expansion to 12 stories	$1.35	$1.95

small to warrant careful consideration wherever land is costly or in short supply. The premium of $1.35 per square foot to make the smaller building expandable to 12 stories is still only an increase of 6.7% and might warrant serious consideration.

The premium of $1.95 per square foot to make the smaller building expandable to 12 floors on pile foundations is 9.0% and in most cases might eliminate this consideration.

Modern buildings often carry a great deal of mechanical equipment on the roof, such as fans and air-conditioning equipment. In expanding a building vertically, it is not necessary to move all this equipment to a new roof. This mechanical floor can be the top of the original building and a middle floor of the ultimate building. Thus, only the elevator machines would have to be moved to a higher floor in an ultimate vertical expansion.

POSSIBLE CONVERSION OF NEARBY COMMERCIAL OR INDUSTRIAL BUILDINGS FOR EDUCATIONAL USE

Question 5: If adjacent land is already occupied by commercial and industrial buildings, and if there is an urgent need to provide additional educational space at the earliest possible date, what are the considerations that enter into purchasing and converting such buildings?

Consideration of time, money, esthetics — and even practical politics — can enter into any conversion of nearby commercial and industrial buildings for educational purposes. Obviously, there can be no universal rule which applies to all situations. However, the general approach to the particular situation on the Drexel campus may suggest a procedure useful in other settings.

Drexel is located in an area certified for redevelopment and will eventually receive special assistance through the established urban renewal channels. However, pressure on present facilities and anticipated further increases in enrollments have made imperative an immediate expansion of educational facilities. Immediate pressure stems from the fact that a large class of freshmen was admitted in the fall of 1959 in expectation that space to accommodate these students as juniors in 1962 could be built or rented.

Little open land of a completely satisfactory character could be located in the immediate neighborhood or at reasonable terms. A minimum of 18 to 24 months' delay was involved in any attempt to obtain land through redevelopment channels, with or without benefit of write-down assistance.

Immediately behind the main buildings of the Institute there was a 7-story warehouse building which had been on the market and which, in the normal course of events, might have been included in a Drexel contract with the Redevelopment Authority and torn down. The cleared land would then have been made available to Drexel.

The procedure used in an analysis of the Red Lion Storage Building to determine the advisability of adapting it for educational purposes involved the following steps:

1. The warehouse building was examined carefully to determine its condition with particular attention to its structural condition since it was assumed that most of the mechanical parts would have to be replaced.
2. A preliminary plan was drawn to show how the building might be used and how it might be treated architecturally.
3. A careful estimate of reconversion cost was prepared by taking off quantities by each building trade.
4. A cost estimate for a new building of comparable size was determined.
5. A table was prepared showing the total cost of the conversion job at varying purchase prices for the old property, and a similar table showing the total cost of the new building at varying purchase prices for land for the new building. As soon as the purchase price of the old property and the cost of the new land was known, the two projects could be directly compared.

So that Drexel might act promptly, a separate, detailed report on the conversion potential of the Red Lion Storage Building was prepared for Drexel by the Educational Facilities Laboratories consultant in advance of the completion of the total survey project.[8]

In summary, it was found that the 50′ width and the 220′ length made the Red Lion Building ideal for conversion to academic use. Its location on Market Street provided an impressive entrance to the Drexel campus from that direction.

A bridge could be constructed to link it with the Main Buildings. With or without a bridge, it would clearly permit Drexel to continue an intensive utilization of space through central scheduling for there is no significant flow of traffic on Ludlow Street which separates the Red Lion Building from the Main Building.

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[8] "Conversion of the Red Lion Storage Warehouse to Educational Uses," a Report to Drexel Institute of Technology, Philadelphia, Pa., prepared by Frederic C. Wood, Consulting Engineer, Cat Rock Road, Cos Cob, Conn., September 9, 1959.

One of the most persuasive conclusions of the study was that the renovation would save at least a year in time and at least $400,000 in total cost. Furthermore, construction could be so phased that, once the exterior of the building was completed, the separate floors could be put into use in sequence while work on the balance of the interior was in progress.

PHASING OF FINANCING AND CONSTRUCTION WITH REGARD FOR INFLATION

Question 6: To what extent should progressively rising building costs and general prices be taken into account in phasing the financing and construction of a physical plant adequate to meet future needs?

The Turner Construction Company's Building Cost Index indicates that a cost in 1939 of 100 would in 1959 be 323 or an increase of over 3 times. It is interesting to note that the Consumers Price Index (U.S. Department of Labor) in 1939 was 59.4 and in 1959 was 124.6 — an increase of about two times. Obviously the cost of buildings has risen much faster than the cost of consumer goods.

If an educational institution needed a $1,000,000 building in 1939, it could have borrowed the money and paid it back over a 20 year period with 22% interest on the unamortized balance and it would have had a total expenditure of $3,200,000. This is the same as the cost of the building new in 1959. In the meantime the building would have been in use for 20 years.

Looking at it another way, if the $1,000,000 had been borrowed at 6% interest and amortized in 20 years, the cost, including the interest, by 1959 would have been approximately $1,600,000 as against a cost of $3,200,000 if the building were built in 1959.

The rise in construction costs during this 20 year period is unusual — it covers 2 wars. There is no reason to expect a repetition of this tendency in the next 20 years.

On the other hand such startling figures justify these observations:

1. The financing of college buildings through loans, where obtainable, is just as sound as the financing of commercial or industrial buildings by this method, particularly if the building is income producing — e.g., a dormitory.

2. If colleges operated on a true profit and loss basis and set tuition to recover all operating costs, including the cost of interest and amortization on buildings, there would be the equivalent of income on all the buildings. Deficits would then be more truly reflected and they would be subsidized through endowment income, annual gifts or state support but would not be buried.

3. If new buildings were constructed on borrowed funds rather than outright governmental subsidy, there would be greater urge to exercise economy.

4. Colleges might change the focus of their fund raising from large sums for capital purposes to annual giving and the build-up of endowment income.

During the four years required to raise funds for the erection of the new Drexel Library Center, the construction cost index rose from 100 to 108. The Library Center, built in 1959 at a cost of $1,514,000, exclusive of land, has already made possible a 100% increase in enrollments in the Graduate School of Library Science.

THE PARKING PROBLEM

Question 7: What is the most satisfactory and economical way of resolving the parking problem of urban educational institutions?

Because of the different circumstances which prevail on various urban campuses, no single answer to the student parking problem can have universal application. In a situation such as that at Drexel where 80% of the day students and close to 100% of the evening graduate and undergraduate students commute — some from distances up to 50 miles — reasonable allowance for faculty and student parking must be made.

Previous studies of the parking needs of Drexel had been made both by Cooper, Alvare, and Harkins, in conjunction with the general campus development plan

submitted to the City Planning Commission in 1957, and by Baader, Young, and Schultz, Architects, in September, 1958.

The former, a projection to 1970, showed space for only 770 cars. The latter indicated a probably need for 1037 parking spaces by 1970. Since 700 parking stickers are currently issued for daytime use, a projected need for as many as 1200 parking spaces by 1970 is now probably more realistic than the projection made in 1958.

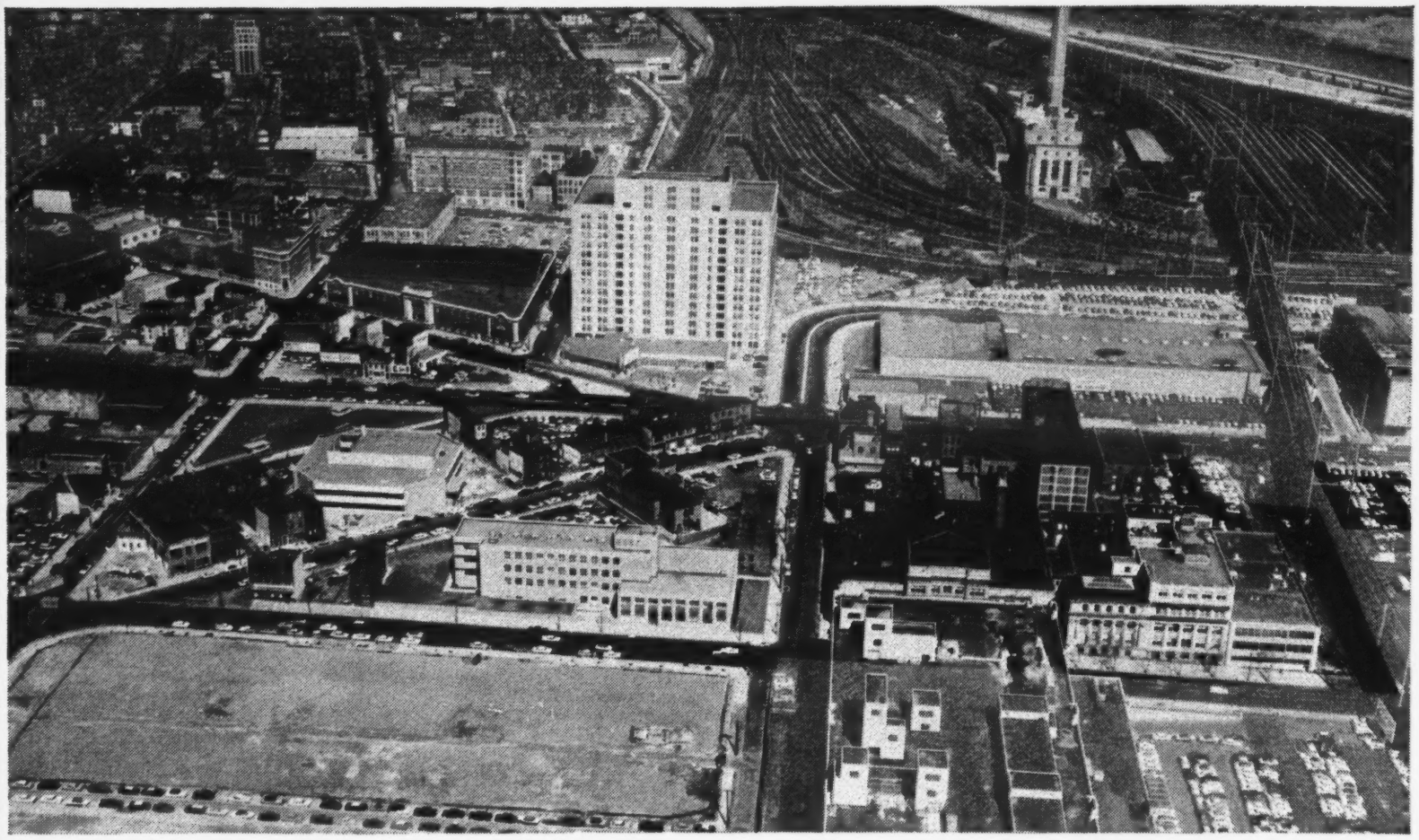
The situation confronting Drexel was probably typical of most urban institutions in these respects:

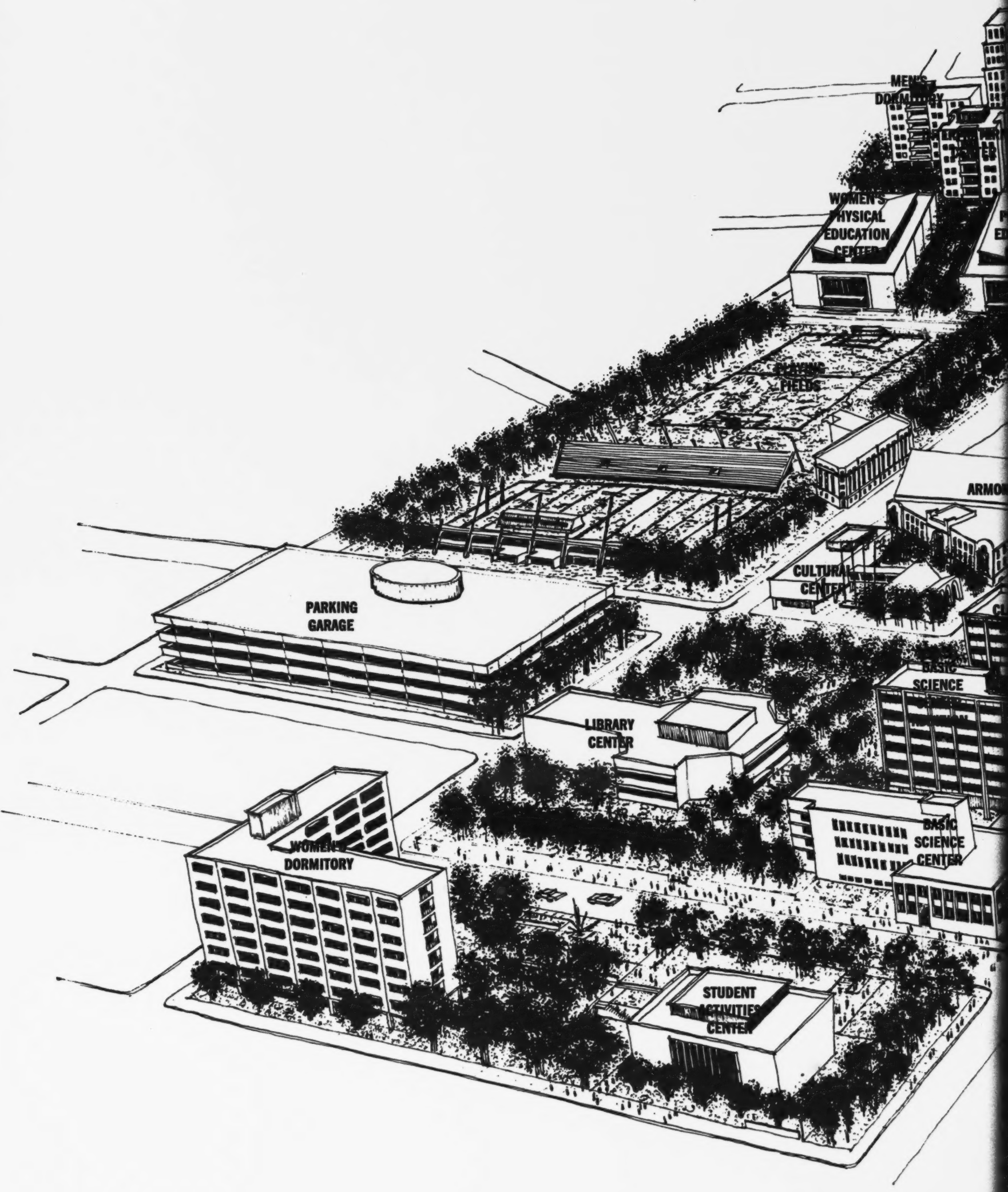
1. Open space owned by the Institute was, in most instances, scheduled for future campus building sites.
2. Additional land for parking could be obtained only by purchasing and razing buildings now used for commercial, industrial or residential purposes. Such land was costly — in some cases more than $10 per square foot. Each campus improvement helped to raise further the price of adjacent land.
3. There were such competing demands for parking space by non-Drexel students in the area — and by students from the nearby University of Pennsylvania — that it was necessary to provide supervision for Drexel parking lots from 7:00 A.M. until 10:00 P.M.

A review of the comparative costs of constructing and maintaining multiple-story open-air parking garages and the cost of purchasing and maintaining the land led to this conclusion: When the cost of land approaches $5 per square foot, a multiple-story, open-air parking garage with ramps for access to the floors should be considered. At this point the cost per square foot of a garage and the cost of land, plus surfacing, is about equal. With the garage, the cost of control (keeping out those not wanted) and the cost of maintenance and snow removal will be lower.

Surveys revealed that other urban institutions are moving toward parking garages. Massachusetts Institute of Technology is about to construct a 400 car facility of this type.

Aerial photo of the general area in which Drexel Institute of Technology is situated. The outline below defines the campus area set forth in the 1957 Cooper, Alvare and Harkins study. On the following pages is an illustration of Mr. Wood's recommended modifications of this plan (see pages 14-17) as visualized by Nolen and Swinburne, architects.




MEN'S
DORMITORY
WOMEN'S
PHYSICAL
EDUCATION
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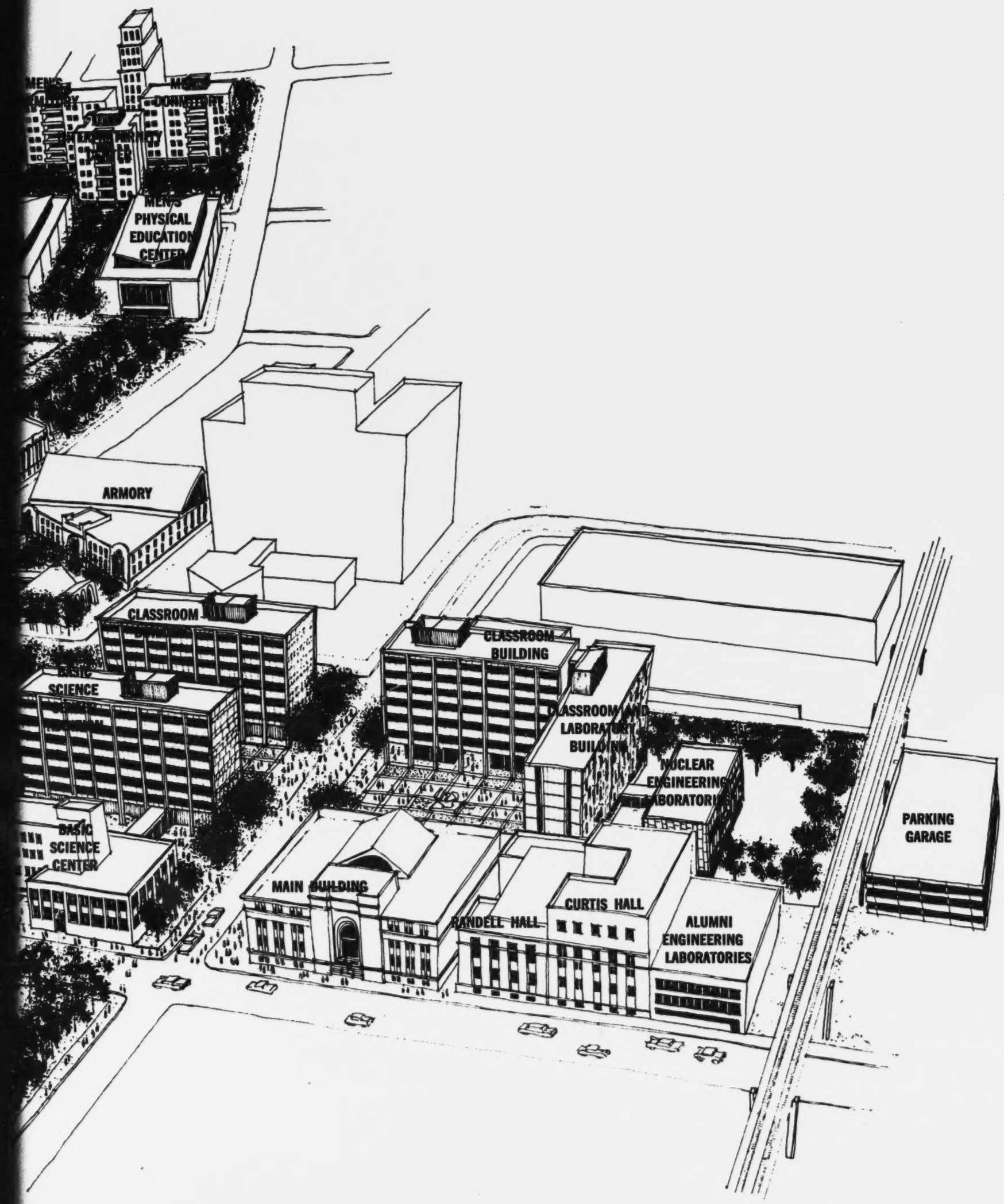
PLAYING
FIELDS
ARMO
CULTURAL
CENTER
PARKING
GARAGE
BASIC
SCIENCE
LIBRARY
CENTER
BASIC
SCIENCE
CENTER
WOMEN'S
DORMITORY
STUDENT
ACTIVITIES
CENTER


MEN'S
DORMITORY
MEN'S
PHYSICAL
EDUCATION
CENTER
ARMORY
CLASSROOM
BUILDING
BASIC
SCIENCE
BUILDING
CLASSROOM AND
LABORATORY
BUILDING
NUCLEAR
ENGINEERING
LABORATORY
PARKING
GARAGE
BASIC
SCIENCE
CENTER
MAIN BUILDING
RANDELL HALL
CURTIS HALL
ALUMNI
ENGINEERING
LABORATORIES

PART III

Action Recommendations for Drexel Institute of Technology

In light of findings and conclusions with respect to the seven basic questions raised during the case study of Drexel Institute of Technology, the following recommendations are made relative to the further expansion of the Institute:

RECOMMENDATION 1 — FUTURE SPACE REQUIREMENTS

In the interest of insuring the maximum educational return for a minimum capital investment, it is suggested that the expanded facilities needed by 1970 for undergraduate instruction be specifically designed to provide a total of 108,500 square feet of space which should include: 38 Classrooms; 9 Laboratories; 2 Large Lecture Rooms, each to seat 200 persons; 2 Small Lecture Rooms, each to seat 100 persons; and 118 Faculty Offices.

In addition 39,770 square feet of space must be provided to replace the temporary facilities now in use which will ultimately be demolished. The total space needs will be 148,270 square feet.

The calculations herein apply solely to the development of facilities for full-time undergraduate instruction and do not make allowances for other educational services which are outlined on page 16 below. Under the pattern of intensive utilization at Drexel, and in light of forecast demands for evening part-time undergraduate instruction and evening graduate instruction, it is reasonably certain that these same facilities will be used to their maximum by the Evening College and the evening graduate divisions of the day colleges.

It is recommended that, in the interest of preserving the present intensive, efficient, and economical use of physical plant, the Institute continue its present policy of central scheduling of space which is used in common by the several colleges of the Institute.

RECOMMENDATION 2 — ARRANGEMENT OF SPACE TO MAINTAIN HIGH UTILIZATION

It is recommended further — and in greater detail below — that facilities for undergraduate instruction be so concentrated that a minimum of down-time is involved in the movement of students between classes.

The minimum length of class periods is defined by collegiate accrediting agencies. If classroom and laboratories are too widely separated, the time required for moving students from one location to another may involve the complete loss of a classroom hour. Each such class-hour loss represents an increase in the daily cost of operating the rooms involved.

Proximity of facilities may be maintained horizontally providing building sites can be located adjacent the existing plant and providing there are no major obstructions to the easy flow of student traffic. There is at present a comparatively easy and unobstructed flow of student traffic both within the four main buildings between 31st and 32nd Streets on Chestnut Street, and between these buildings and the Basic Science Center and the Library Center situated west of 32nd Street. Experience has already shown that the necessity of crossing Market Street, which is a major traffic artery and walking to the Lancaster Avenue Annex increases room-hour costs at both ends of the line. In order to give students more time to make the trip, the class hour was shortened from 55 to 52 minutes several years ago. A major flow of traffic on 32nd Street would, without question, pose serious problems for the Institute in terms of optimum scheduling of facilities and in terms of physical risks for students required to cross from one section of the instructional campus to the other several times per day.

It is important that the trustees and administrative officers of the Institute be alert to the economic and safety implications of any future development of 32nd Street as a heavily traveled, through-traffic artery. Recommendations made herein regarding the effective and economic development of undergraduate instructional facilities are predicated on the assumption that 32nd Street will remain a purely local traffic artery. Ideally, it should be closed completely and integrated into the Drexel campus.

In 1958, the Institute, and the University of Pennsylvania, authorized the firm of Simpson & Curtin, Transportation Engineers, to undertake a study of traffic in the "University City" area. It may be desirable for the Institute to keep this sort of study current in order to be in a position to make construction decisions which take proper account of traffic realities.

RECOMMENDATION 3 — MULTIPLE-STORY BUILDINGS FOR EDUCATIONAL PURPOSES

In light of the findings with respect to the advantages of multiple story buildings for educational purposes, with due consideration for the high cost of additional land in the campus area and with regard for the advantages resulting from compactness, it is recommended that Drexel seriously consider multiple story buildings higher than the conventional 3-story structures as a possible solution for its growing need for additional facilities for undergraduate study.

RECOMMENDATION 4 — ECONOMICS OF BUILDING EXPANDABLE LOW UNITS

Because of the low cost of providing foundations and columns within a three story and basement building (about $.84 per square foot of the original building) to support a later vertical expansion, it is recommended that future Drexel buildings be designed to permit an eventual upward growth if such is desired.

RECOMMENDATION 5 — RENOVATION OF RED LION BUILDING

As previously indicated, to help Drexel act promptly, a separate detailed report on the conversion potential of a specific nearby commercial structure — the Red Lion Storage Building — was prepared for Drexel by Mr. Frederic C. Wood in advance of the completion of his overall findings and recommendations.

In a report dated September 9, 1959, it was recommended that Drexel purchase the aforementioned building and renovate it for educational purposes. The building was purchased on December 15, 1959 at a cost of $248,397.00.

RECOMMENDATION 6 — PHASING OF FINANCING AND CONSTRUCTION WITH REGARD FOR INFLATION

It is appreciated that capital for Drexel's expansion may be accumulated only slowly and that prudent expansion policy may dictate that all future buildings be first constructed as low-rise structures and then expanded later as the need arises and as capital funds are in hand.

While no projections of enrollments can be certified as infallible, the fact remains that statistics of future educational demands are based on demographic data which are actual, not hypothetical.[9] The children who will eventually make application at Drexel have already been born. They are now moving through the grammar and high schools and will graduate at specified dates in numbers which can now be projected with a high degree of accuracy. Everything points to the probability that high school graduates of the foreseeable future will be increasingly aware of the importance and challenge of careers in science, technology, and management fields.

In light of these facts it is suggested that the administrative officers and trustees weigh carefully the projections of prices of real estate, building costs and general prices and consider the comparative savings which may be had by borrowing sufficient funds now to construct a physical plant capable of handling the 1970 student load. Preliminary calculations indicate the possibility of a net saving in capital investment if immediate action is taken.

More than a saving of money is involved. The experiences of other institutions suggest that an early, major move along a broad front by the Institute may have the salutary effect of encouraging and expediting other community improvements which will insure the safety and well being of students, help restore the balance of the student population by increasing the percentage of women undergraduates, and provide an even more wholesome campus atmosphere.

RECOMMENDATION 7 — PARKING

It is recommended that, in the interest of economy, Drexel explore the possibility of constructing a multiple-story, open-air parking garage to meet its parking needs. The problem of central open lots will become increasingly difficult as traffic in the area becomes more dense. Furthermore the experience of other institutions shows that good community relations are often placed in jeopardy when public authorities displace residents and businesses in order to clear lands for student parking.

RECOMMENDATION 8 — FUTURE RE-APPRAISALS

It is recommended that Drexel use the data accumulated in this study for an annual review and reappraisal

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[9] Data for the Greater Philadelphia area were compiled and interpreted by a special Committee on Higher Educational Opportunities in Phila. in Report filed with the Mayor and City Council in January, 1958. Findings of this study confirm the "market" facts established in the Alderson and Sessions study for Drexel Institute of Technology.

of the space problem. Factors to be looked at would be these:

1. The trend of increased enrollment towards the assumed 85% increase by 1970.
2. The trend of enrollment by department and the effect of any deviation from the basic assumptions of this study.
3. Changes in the course requirements for degrees as they might affect these conclusions.
4. Changes in teaching methods which might require rooms of larger or smaller size.
5. The quantity of parking stickers requested.
6. Changes in percentage of resident students (male & female) as it might affect dormitory needs.

RECOMMENDED MODIFICATION OF OVERALL DEVELOPMENT PLANS

Each of the seven recommendations above has a bearing on expansion plans already under consideration by the Institute — especially those based on the Cooper, Alvare and Harkins study of 1957. In the interest of achieving the most efficient plant for undergraduate instructional purposes, it is recommended that consideration be given to modifying the presently proposed plan of campus development as shown in the map on page 3 in the following respects:

1. Building 7 on the attached diagram should be assumed to be the converted Red Lion Building. This will provide 63,500 sq. ft. of the 148,270 sq. ft. of gross undergraduate day college educational space required by 1970. It is assumed that this will be the first unit completed.
2. Building 11 should be constructed next in sequence and should be placed as close as possible to 32nd Street for easy communication with the Main Building. It should be at least a three story and basement building and should be so constructed as to permit vertical expansion up to seven stories. It is estimated that such a building, without fees or equipment, would cost slightly over $1,000,000.

If this were built originally as a seven story and basement building, occupying about 10,000 feet of ground area and with a total gross area approximately 80,000 square feet, it would cost without fees and equipment about $2,000,-000 (at 1960 price level).

3. Next in order of construction would be Building 10 which should occupy about 10,000 square feet of ground space and which should also be as near as possible to 32nd Street for ease of communication with the Main Building. Cost would be approximately as indicated under point 2 above.

Buildings 7, 10, and 11 can be developed in a variety of ways. The alternatives shown in Table II are possible.

The alternatives may be combined in various (See Table III) ways to yield different total square footages: Combinations I and II would yield less than the required 148,270 square feet of space for undergraduate instructional purposes and Combination III and IV would yield more than enough.

UNCALCULATED EDUCATIONAL SPACE REQUIREMENTS

Any "surplus" of space could, in all likelihood, be readily absorbed by demands derived from the expansion of educational services other than day-time undergraduate instruction. Throughout this study, no account has been taken of the following considerations which will increase the demand for educational service and which will require additional facilities:

a. The introduction of full-time graduate programs at the Master's level and the Doctoral level especially in fields of science and technology requiring laboratory research for the preparation of a dissertation.

b. The rapidly growing program of sponsored research.

TABLE II
DEVELOPMENT OF ALTERNATIVES FOR NEW BUILDINGS

Bldg. No.	Alternative	Manner of Development	Sq. Footage Yielded
7	A	7-story-and-basement	63,500
11	B	3-story-and-basement	40,000
11	C	7-story-and-basement	80,000
10	D	3-story-and-basement	40,000
10	E	7-story-and-basement	80,000

TABLE III

COMBINATIONS OF STRUCTURES TO YIELD DESIRED SQUARE FOOTAGE OF SPACE FOR DAYTIME UNDERGRADUATE INSTRUCTION

Combination Number	Combination of Alternatives	Total Square Footage of space for undergraduate instruction	Square footage in column 3 expressed as % of needed 148,270 sq. ft.
I	A + B or A + D	103,500	70%
II	A + C or A + E or A + B + D	143,500	96%
III	A + C + D or A + B + E	183,500	123%
IV	A + C + E	223,500	150%

c. The further development of special educational and research services such as those now offered by the departments of Psychology and Education (testing, remedial reading and advisement) and the Computing Center.
d. The establishment of an expanded program of nuclear engineering or the development of other instructional programs requiring specialized facilities.
e. The provision of the on-campus amenities needed by a commuting faculty and student body (lounges, recreation rooms, etc.)
f. The provision of needed facilities for the ROTC program, physical education, and intercollegiate and intramural sports.
g. The need for additional campus housing, especially for men students, and for certain housing facilities for the instructional staff.

FURTHER DEVELOPMENT RECOMMENDATIONS

4. It is recommended that space needs for the above listed educational services be defined as quickly and as precisely as possible so that requirements can be taken into account in the development of the area around Drexel.
5. A next logical step would be the acquisition of the Market Street property between the Red Lion Building and 32nd Street for an ultimate structure, beyond 1970, which could begin as a three-story-and-basement building with built-in allowances for vertical expansion.
6. Under the changes of plans for undergraduate educational plant suggested above, sites 9 and 12 on the map on page 3 could be designated for uses other than undergraduate education. Consideration might be given to the possibility of using site 9 as a possible location for a Women's Dormitory, reserving the Powelton Avenue area for Men's Dormitories. Site No. 12 might be considered as a possible site for multiple-story parking garage. It is suggested that the property owned by Drexel east of the Pennsylvania R.R. high line also be used for a multiple story parking garage.
7. It is suggested that the block bounded by Arch Street, Race Street, 33rd and 34th Street be made the indoor physical education center. This would make it possible to remedy a serious deficiency in Drexel's present setup, —the absence of readily accessible playing fields. These fields could be located in the block bounded by Market, Arch, 33rd and 34th Streets.
8. The present Women's Dormitory might be converted to a Men's Dormitory. The remaining area in block, Powelton to Race, would provide space for additional men's dormitories, a dining facility and possibly an Interfraternity Center patterned after the one at Brown University.

INDEX TO EXHIBITS

Exhibit A: Interpretive Memorandum to the deans of the several Drexel colleges outlining basic assumptions and procedures to govern calculation of space needed for the number of full-time undergraduate students projected for 1970.

Exhibit B: Master Form used for calculation of future space requirements.

Exhibit C: Detailed instructions for employment of Master Form in calculation of future space requirements.

Exhibit D: Summary of Drexel's need for additional classrooms for instruction of full-time undergraduate students.

Exhibit E: Form used to define extent to which existing laboratories and lecture rooms are used throughout the day for full-time undergraduate students (day starting at 8:00 A.M. and ending at 5:30 P.M.).

Exhibit E-1: Form used to project additional laboratories and lecture rooms required. This form was employed only after the existing facilities specified in Form E were filled to capacity (See item 13 in Exhibit C).

Exhibit F: Memorandum to the deans of the several Drexel colleges requesting estimates of future number of teaching personnel in order to provide basis for calculating office requirements for 1970.

Exhibit G: Table summarizing response to questionnaire regarding future number of teachers (see Exhibit F) and providing estimate of number of additional faculty offices required by 1970.

Exhibit H: Summary of new space needed for full-time undergraduate educational use (e.g. exclusive of requirements for research, housing, parking, special projects, etc.).

EXHIBIT A

July 27, 1959

Memo to the Deans:

Through a grant made by the Educational Facilities Laboratories, Inc., to Drexel, studies are being made this summer to explore ways of expanding our physical facilities to meet the growth in student enrollment of 85 per cent by 1970 as projected in the Alderson and Sessions report. We are seeking ways of expansion which will be logical, economical, and flexible and which will permit us to continue our high utilization of space, the economy of which is essential to our successful operation.

Frequently, future space requirements are determined by a purely statistical method based upon the number of square feet per student needed for classrooms, laboratories, lecture rooms, and staff offices. This approach has weaknesses. It cannot adequately allow for the wide variation in space needs of widely varying courses, and hence too much or too little of one kind of space or another may be provided. It gives no concise consideration to the size of individual rooms for various uses other than by a consensus. It leaves no base or background for review of space needs as the nature of the courses of instruction may change or as the proportion of student enrollment in various courses may change.

We hope to develop an approach and a result which will be somewhat different and which will overcome some of these deficiencies of the square foot per student method.

It seems logical to us to approach the problem through consideration of the specific courses of instruction we give and the types and sizes of space, and frequencies of use which these courses require. We are agreed that there is an ideal unit or increment of growth in any curriculum, based upon the most economic use of instructional time, and that the size of this increment may vary substantially between various schools or departments. Although we have no illusions that we can control enrollment to the most ideal sizes or blocks, it still remains the logical unit around which to plan space needs. In our expansion we will grow from tight vests (with which we are presently familiar) to rather loose and oversized clothing, and then back to the tight vests again.

After several meetings of the deans we have worked out the information which seems essential to determine the future space needs of Drexel. We must get this information from you. An outline of some of the basic assumptions and of the information wanted is attached.

It would be most helpful if we could have this information, to be filled in by you on the accompanying spread sheets, (Exhibit B) by_____.

Determining the Future Space Requirements at Drexel

(1) This determination will be made on the over-all estimate made by Alderson and Sessions that the total student enrollment should increase 85 per cent by 1970.

(2) It will be assumed that the growth will be generally uniform in all colleges and courses except where known factors indicate otherwise, such as:
   a. The Graduate School
   b. Science programs leading to a B.S. degree
   c. Doctorate programs

(3) It will be assumed that the growth of the physical plant will be fitted to the requirements for day instruction and that this will either be more than adequate for the evening college or the size of the evening college will be tailored to the space available.

(4) It will be assumed that:
   a. There will be no Saturday morning classes.
   b. There will be no 8 A.M. classes.
   c. One 2-hour period in an afternoon will be used for student activities.
   d. One 2-hour period in an afternoon will be used for military training.

(5) It will be assumed that no more space will be added to the library by 1970 and that the School of Library Science will only report the following information:
   a. The maximum student capacity of the new School of Library Science building.
   b. Number of additional teaching and clerical staff required to take care of that capacity.
   c. The maximum student population at Drexel which the library will accommodate.

(6) Other deans will report as follows (again, in the appropriate columns of the spread sheets):
   a. What unit or increment of growth in number of students is the most economic in each of the areas of instruction such as Civil Engineering, Electrical Engineering, Home Economics, Business Administration, Physics majors, etc. The size of these units will vary depending on the nature of the courses and the number of students needed to get the maximum use of the instructional time. Consideration must be given to each term of the course and the effects of attrition on the later terms.
   b. Number of students for each increment of growth; the number of sections required for each course of instruction for each term; the optimum and maximum number of students per section; the nature of the room required for instruction — recitation, lecture, laboratory, etc.; and whether this room is a "specialized room"—that is, a room specially equipped for that particular course — and can be used only for that course or may be used for other purposes.
   c. Where a course is given by another department, indicate the total number of students only. The number of students per section and number of sections will subsequently be determined by the other department.
   d. For each increment of growth, the dean will also report any increase in teaching, clerical, or administrative staff, by title, such as "1 professor, 2 assistant professors, 2 instructors, 1 secretary, 1 clerk."

(7) After reports are assembled from each department or school, the number of students reported as requiring service courses from other departments will be abstracted, assembled, and reported to each of the servicing departments for their indications of the number of sections and the optimum number and maximum number per section.

(8) The Dean of Admissions will predict the growth of student enrollment in the various areas of instruction in conference with the dean or department head.

EXHIBIT B

KEY
C.R.—CLASSROOM RECITATION
L.R.—LECTURE ROOM
S.R.—STAFF ROOM
L. —LABORATORY

DREXEL INSTITUTE OF TECHNOLOGY

SPACE REQUIREMENTS

SHEET NO.____
OF____SHEETS
DATE:_____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
ASSIGNED ROOM	COURSE	FALL 1968 No. OF STUD.	No. OF SECT.	OPT. ROOM No. OF STUD.	MAX. No. OF STUD.	TYPE OF ROOM	PERIODS PER WEEK	PERIOD LENGTH (HRS.)	PREP-MASTER TIME	POSS. ADD'L. STUD.	PRESENT SPACE				ANTICIPATED INCREMENTS BY SCHOOLS																			1970									
															ME	EE	CE	MetE.	ChE	Phys.	Chem.	BIOL. SCI.	4-YR BA	ADM. SEC.	BUS. TY	RET. MGT.	JR. SECL.	COOP BA	COM'L ENG.	HOME EC.					TOTAL	No. OF SECT.	SALARIES /AVG. /SECT.	TOTAL RM. HRS.					

EXHIBIT C

INSTRUCTIONS FOR USE OF MASTER FORM*

1. Have a quantity of "spread sheet" forms (Exhibit B) duplicated for distribution to each department. Number these by department. Suggest the form be enlarged to get more space in each column. Department heads will fill in the required information so that the form becomes part of the departmental report. Information from these reports will subsequently be abstracted to provide a summary of present and future needs. A copy of the same form may be used for a final summary.

2. Column 1 is to be used to show the actual room number of the room now used for lecture or lab courses — not necessary for classrooms.

3. Column 12 is to be used to indicate if room presently occupied — lecture or laboratory — is unsatisfactory for the course.

4. Abstract from department reports the added number of students expected in each course by 1970 and enter in department column on "spread sheet" — from those reports, columns 2, 7, 8, 9, 10, and 16 through 31 can also be filled in.

5. A sheet or sheets for such courses as English, Math, Social Science, Language, or any other courses not falling in a major department category will probably be needed.

6. When columns 16-31 are complete, suggest meeting with department heads to check the following:
   a. Actual room number for lecture or lab courses— Column 1.
   b. What other courses can be handled in same lab or lecture room.
   c. Number of students in course in Fall 1959 (or Spring 1959) — Column 3.
   d. Number of sections in course in Fall 1959 (or Spring 1959) — Column 4.
   e. Optimum number of students per section —Column 5.
   f. Maximum number of students per section — Column 6.
   g. Verify type of room (Column 7) and if that room can be used for only that course.
   h. Check periods and length of periods — Columns 8 and 9.
   i. Check if "preparation time" must be allowed for lab or lecture room — Column 10.
   j. Check to see that every course taught by the department is shown in Column 2.

7. Add Column 3 to 16 through 31 and indicate in Column 36 (Total Students).

8. Divide Column 36 by Column 5 to get Column 37 (Number of Sections).

9. Multiply Column 8 by Column 9 and add Column 10 to get Room-Hours/Wk/Section — Column 38.

10. Multiply Column 37 (Number of Sections) by Column 38 (Room-Hours/Wk/Section) to get Total Room-Hours — Column 39.

11. Add up total *classroom hours only* by department and show on bottom of last departmental sheet.

12. Prepare actual *room schedule* by hours and days of week for each laboratory and lecture room (or other special room such as seminar) now in existence. See Exhibit E, Sample Schedule for laboratory and lecture rooms.

13. After available hours are used up for *Rm. 202* make a schedule card for 202-A — then 202-B, etc. Thus it will be possible to determine how many rooms *like* 202 will be needed. See Exhibit E_1.

14. Abstract for Home Economics only the courses outside of that department (service courses such as Chemistry, Biology, etc.). The Home Economics Department itself will be handled separately.

**See Exhibit "B" above.*

EXHIBIT D

DREXEL

SUMMARY OF CLASSROOM NEEDS

Classroom Hours -- 1970

Engineering	1479	
Business Administration	997	
Service Departments	1029	
	3505 + 31 =	114 C.R.

Existing Classrooms	75
Additional Required Classrooms	38

EXHIBIT E

LABORATORY AND LECTURE ROOM SCHEDULE

Electrical Engineering Lab, Room No. _____ (Existing)

HR.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
8:00						
9:00						
10:00						
11:00						
12:00						
1:30						
2:30						
3:30						
4:30						

EXHIBIT F

Present Teaching Staff and Faculty Additions Required by 1970

Memo to Deans:

Attached are lists showing the anticipated number of sections in each course in 1970. From this we are determining the space required for classrooms, laboratories, lecture rooms, and all spaces needed for teaching.
We must also now determine the space required for the teaching and administrative staff. Will you kindly ask each department head to list for you the number of people, by title or classification, who are presently employed, and the number of people who will be needed to carry this teaching load in 1970.

A sample listing might look like this:

	1960	1970
Professors		
Associate Professors		
Assistant Professors		
Instructors		
Laboratory Assistants		
Lecturers		
Clerks		
-etc.-		

Will you kindly review and approve the list and forward it to me not later than_____.

(Signature)_____

EXHIBIT E-1

An identical schedule card headed
"Electrical Engineering Lab, Room No._____
(Anticipated Addition — 1970)"
was also filled out.

EXHIBIT G

PRESENT FACULTY OFFICES AND ADDITIONAL OFFICES REQUIRED BY 1970

Department	Professors		Associate Professors		Assistant Professors		Instructors		Lab. Assistants		Lecturers		Secretaries		Clerks		Misc.	
	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70
																	Lab.	Sup.
Home Economics	7	9	9	10	6	8	8	9	5	6	1	0	3	6	0	0	0	1
Chemical Eng.	1	2	1	1	1	2	1	2	2	3	0	0	1	1	0	0	0	0
Civil Eng.	2	3	2	4	4	8	6	9	1	2	1	0	1	2	0	0	0	0
Mech. Eng.	6	12	4	10	4	10	7	16	0	0	1	2	1	2	0	1	3	7
																	Lab.	Techs.
Metal. Eng.	1	2	1	1	1	2	5p/t	3	0	0	0	0	0	1	0	0	1	1
Elec. Eng.	3	6	5	9	3	9	11	14	3	5	0	0	1	1	0	0	0	0
Physics	4	5	2	5	3	7	4	10	1	2	0	0	1	2	0	0	5	10
Chemistry	5	10	5	10	1	4	4	8	10	15	1	1	1	2	4	7	0	2
Mathematics	4	8	4	10	3	10	9	10	0	0	0	0	1	1	0	0	0	0
Merchandising	1	1	2	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Accounting	1	2	2	3	4	7	3	5	0	0	0	0	0	1	0	0	0	0
Economics	1	4	5	5	2	6	2	8	0	0	4	5	0	2	0	0	0	0
Social Science	1	4	4	7	4	8	2	3	0	0	2	3	1	1	0	0	0	0
Secretarial	3	1	0	3	2	1	0	3	0	0	0	0	0	0	0	0	0	0
English	2	6	6	10	5	10	9	18	0	0	0	0	0	0	0	0	0	0
Finance	1	2	1	3	1	3	1	2	0	2	7	3	0	1	0	0	0	0
Physical Ed.	0	0	3	5	0	0	4	8	0	0	0	0	0	0	0	0	0	0
Foreign Language	0	1	1	2	1	0	2	3	0	0	0	0	0	0	0	0	0	0
TOTAL	43	78	57	99	45	96	78	132	22	35	17	14	12	23	4	8	9	21
People per Office		1		2		2		2		0		5		4		4		0
OFFICES REQUIRED 1970		78		50		48		66		0	Allow-3		Allow-7		Allow-2			0

Total Offices Needed 1970 = 254
Existing Offices 1960 = 136
Additional Offices Needed = 118

EXHIBIT H

Summary of New Space Needed for Full-Time Undergraduate Educational Use*

	Present Number	*Present Area*	*Average Area*	*1970 Required No.*	*Added Number*	*Added Area*
Classrooms	76	42,937	565	114	38	21,500
Laboratories	81	83,476	1,030	90	9	9,000
Drawing Rooms	14	14,414	1,030	16	2	2,000
Faculty Offices	136	24,640	181	254	118	22,200
Lecture Rooms including above	—	—	—	—	1	4,000
TOTAL	—	165,467	—	—	—	58,700
Accessory Education Space	25%	40,700	—	25%	25%	14,600
TOTAL	—	206,167	—	—	—	73,300
Maintenance Space	11%	22,700	—	11%	11%	8,100
TOTAL	—	228,867	—	—	—	81,400
Circulation and Service	33%	75,500	—	33%	33%	27,100
TOTAL	—	304,367	—	—	—	108,500

New Space Required Gross = 108,500 sq. ft.
Old Space Required Gross = 304,367 sq. ft.
% Increment = 36%

To this must be added replacement of space to be demolished or vacated:

Lancaster Ave. Annex, Woodland Ave. Annex, Math. Bldg., A-Annex, B-Annex

14 Classrooms at 565 sq. ft.	7,900	
1 Laboratory	1,000	
37 Offices at 180 sq. ft.	6,660	
6 Drawing Rooms at 1,000 sq. ft.	6,000	
Total	21,560	
Accessory Education Space (25%)	5,390	
Total	26,950	
Maintenance Space (11%)	2,960	
Total	29,910	
Circulation and Service Area (33%)	9,860	
Total	39,770	39,770
TOTAL NEW SPACE		148,270

** See page 15 of text for list of other needs not covered by this calculation — e.g., research, housing, parking, special projects, etc.*